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NITROGEN IN SURFACE RUNOFF AND SEDIMENT

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INTRODUCTION

Soil management practices can critically affect the amount of nutrients in sediment and surface runoff. Reducing the amount of erosion is considered crucial, and modern tillage systems are frequently aimed at this goal. Soil management practices that reduce the amount of soil erosion may not reduce water soluble nutrient concentrations, but can be effective in reducing total nutrient loss by controlling the amount of sediment-transported nutrients (Barisas et al., 1978).

In eastern Oregon and Washington, where greater than 60 percent of the annual precipitation occurs from November through April (Douglas et al., 1988), surface runoff and erosion events occur infrequently during a typical year. An event is usually the result of unique weather and soil conditions, and a few extreme events generate most of the surface runoff and eroded sediments (Zuzel et al., 1993). The purpose of this study was to evaluate the effects of a wheat-pea rotation on the amount of nitrogen in surface runoff and eroded sediments.

MATERIALS AND METHODS

Six plots were established on the Kirk farm in the fall of 1977 on a 16 percent north-facing slope in the foothills of the Blue Mountains of northeastern Oregon. However, data to evaluate N in runoff and sediments were collected only in crop years 1980 through 1984. The 0.03 acre (110 by 13 ft.) plots were on a Thatuna silt loam (fine-silty, mixed mesic Xeric Argialboll) soil, located approximately 10 miles east of the Columbia Plateau Conservation Research Center at an elevation of 2,400 ft. The plow layer had greater than 4 percent organic matter and there was a slowly permeable clay layer at a depth of 30 in. Four of the plots were in a wheat-pea rotation during the experimental period. These plots had fall-seeded winter wheat (WW) (*Triticum aestivium,* L.) one crop year followed by spring-seeded fresh peas (SP) (*Pisum sativum L.*) the next crop year. During any given crop year, two plots were seeded to wheat and two to peas. Two plots were maintained in continuous fallow (CF) throughout the study.

All plots were moldboard plowed cross slope, disked, and springtoothed and/or harrowed up-and-down slope in the fall. Up and down slope tillage is a very poor practice, however, these plots were initiated primarily to monitor erosion and evaluate the Universal Soil Loss Equation (USLE) factors. This type of tillage was done to give the practice factor of the USLE a value of one (Zuzel et al. 1993). All fertilizer was surface-applied by hand at recommended rates for each crop. Winter wheat plots were fertilized with 50 lb N/acre as either ammonium nitrate or ammonium sulfate, packed, and seeded with a double disk drill in an up-and-down slope direction in the fall. They were topdressed in the spring with 50 lb N/ac. Pea plots were tilled in the fall, kept weed free with herbicides over winter, fertilized at seeding with 16, 20, and 11 lb N, P, and S/ac, respectively, and seeded up-and-down slope in the spring. Continuous fallow plots received a simulated seeding (no seed) with the same double disk drill in the fall and were never fertilized throughout the study.

After planting, plot borders were installed in October and removed in May, to contain surface runoff within plots and keep outside contamination to a minimum. Plot border installation and runoff and sediment collection are explained by Zuzel et al. (1993). Sediment concentration was calculated using the difference between the wet and oven dry weights and the liquid volume. Samples were analyzed for total N (TN) and soluble nitrate and ammonium N (SOL-N).

Sediment N (SED-N) in lb/ac was determined by subtracting SOL-N from TN. Flow weighted SED values (lb/ton) were calculated by dividing SED-N by the amount of transported sediment (ton/ac) (Laflen et al., 1984). Flow weighted SOL-N values (lb/ac-in) were determined by dividing SOL-N by inches of surface runoff. (Alberts et al., 1978).

RESULTS AND DISCUSSION

Average annual precipitation during the five year study was 25 in., which is slightly above average (23 in.), and ranged from 21 in 1980 to 28 in 1983. Approximately 80 percent fell during October to May when plot borders were in place (Fig. 1). There were a total of 258 measurable events during the study period, 112, 35, and 111 from the WW, SP, and CF plots, respectively (Fig. 2). These numbers differ from values in Zuzel et al. (1993) as they evaluated 12 years of data and only reported on erosion events greater than 225 lb/ac. Precipitation during September through December was 37 percent of the total for five years, and resulted in 12, 0, and 16 percent of the runoff events for WW, SP, and CF, respectively (Fig. 1 and 2). These low percentages are probably the result of time required to fill the soil profile with water (approximately 6 to 9 in.) to a depth of 48 to 60 in. after rains start in the fall.

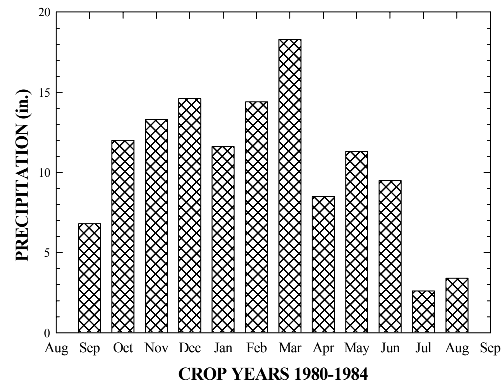

Figure 1. Average monthly precipitation at the Kirk farm for 1980-1984.

Events during February and March accounted for 53, 63, and 46 percent of the WW, SP, and CF events, respectively (Fig. 2). Thus, the largest number of events occurred after the soil profile was saturated during the winter.

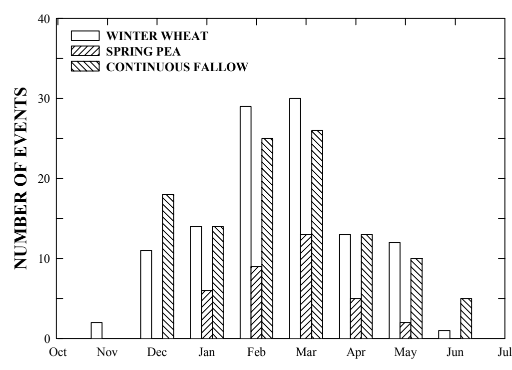

Figure 2. Number of measurable erosion events at the Kirk farm during 1980-1984.

Soluble N from each treatment varied widely from year to year (Fig. 3), however, highest values were during

January, February, and March. Soluble N concentrations were consistently highest for the WW treatment, which had mean weighted SOL-N concentrations of 0.1 lb N/ac-in of runoff for an individual event and a five-year total of 11.7 lb N/ac-in. Both spring peas and continuous fallow had mean concentrations of 0.07 lb N/ac-in., and five-year totals of 4.8 and 6.9 lb N/ac-in., respectively. Nitrogen mineral-ization from soil OM probably accounted for the SOL-N lost from the CF treatment as there was no fertilizer applied during the five years.

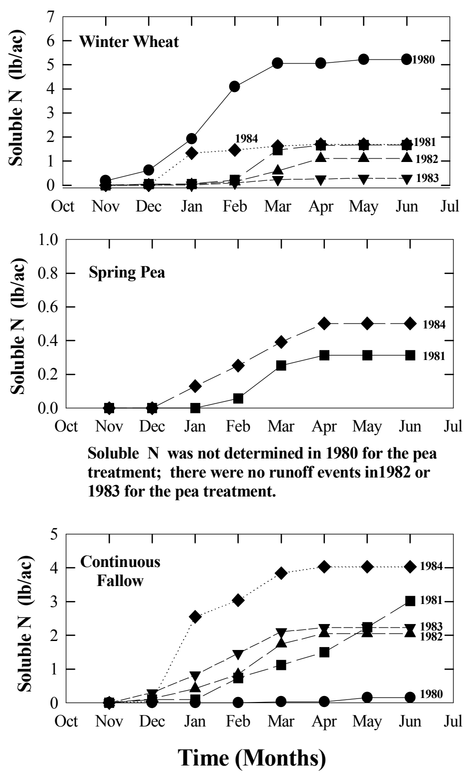

Figure 3. Cumulative soluble nitrogen for each treatment at the Kirk farm for years when there were measurable events.

Soluble N was a very small proportion of the N applied as fertilizer. Soluble N in surface runoff from the WW and SP treatments never exceeded 6 and 4 percent of the 100 and 16 lb N/ac/yr applied as fertilizer, respectively. This represented less than 2 percent of the total fertilizer N applied over the five-year period for both treatments.

Most of the N lost was associated with sediment loss (Fig. 4). The WW, SP, and CF plots had total sediment losses over the five- year period of 61, 10, and 260 tons/ac, respectively. Mean lbs of SED-N lost per ton of sediment lost, was 3.0, 4.4, and 2.0 for WW, SP, and CF, respectively. The high value for SP was a result of fertilizing and seeding in the spring when the soil was saturated with water. Thus, any precipitation that fell on the essentially bare soil surface resulted in loss of soil and nutrients. Winter wheat was also fertilized in spring, however, wheat plants had grown

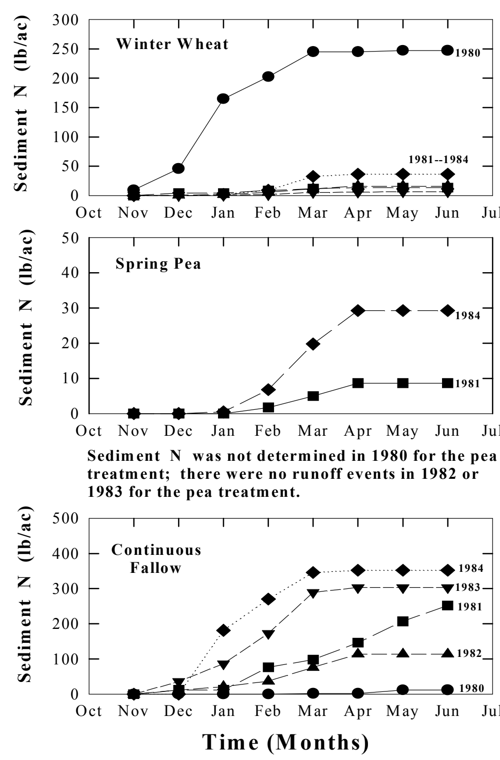

Figure 4. Cumulative sediment nitrogen for each treatment at the Kirk farm for years when there were measurable events.

over winter, removing soil moisture and creating ground cover to help control runoff and erosion.

CONCLUSIONS

Soluble N averaged less than 2 percent of the total N applied as fertilizer over the five year period for both the WW and SP treatments. Thus, fertilizer applied at recommended rates to this steeply sloping land was not an important source of N in surface runoff. Sediment N was the most significant source of N in surface runoff events. It is imperative that sediment loss be minimized to reduce the amount of N contaminating surface waters. Management systems that keep residues on the soil surface and even slightly reduce tillage will greatly decrease the amount of sediment loss and thus N loss.

REFERENCES

Alberts, E.E., G.E. Schuman, and R.E. Burwell. 1978. Seasonal runoff losses of nitrogen and phosphorus from Missouri Valley loess watersheds. Journal Environmental Quality. 7:203-208.

Barisas, S.G., J.L. Baker, H.P. Johnson, and J.M. Laflen. 1978. Effect of tillage systems on runoff losses of nutrients, a rainfall simulation study. Transactions American Society Agricultural Engineers. 21:893-897.

Douglas, Jr., C.L., R.W. Rickman, J.F. Zuzel, and B.L. Klepper. 1988. Criteria for delineation of agronomic zones for the dryland Pacific Northwest. Journal Soil Water Conservation 43:415-418.

Laflen, J.M. and M.A. Tabatabai. 1984. Nitrogen and phosphorus losses from corn-soybean rotations as affected by tillage practices. Transactions American Society Agricultural Engineers. 27:58-63.

Zuzel, J.F., R.R. Allmaras, and R. Greenwalt. 1993. Summary of 12 years of runoff and erosion measurements at a site in the foothills of the Blue Mountains. Special Report 909. Columbia Basin Agricultural Research Annual Report. pp. 104-108. OSU and USDA-ARS, Pendleton, OR.